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Four-year development of a centipede (Chilopoda) community after a summer flood

by

Ivan H. Tuf

(Department of Ecology and Environmental Science, Faculty of Science, Palacky University, Svobody 26, CZ-77200 Olomouc, Czech Republic; tuf@prfnw.upol.cz)

ABSTRACT

In July 1997 a disastrous summer flood affected extensive areas of Moravia in the Czech Republic. During the years 1998–2001 the development of communities of centipedes (Chilopoda) were studied in floodplain forests along the Morava River in the Litovelské Pomoraví Protected Landscape Area. Three floodplain forests of different ages (3, 30 and 80 years old) were investigated. Centipedes were extracted from soil samples and trapped by pitfall traps.

In the first year, densities, epigeic activity and numbers of species were low. Over the study period, endogeic densities of centipedes increased significantly at all sites, and the number of species was highest in the fourth year. Dominant species were *Lithobius mutabilis, Lithobius forficatus, Geophilus flavus, Schendyla nemorensis* and *Strigamia acuminata*. Three uncommon species appeared in the last year: *Lithobius austriacus, Strigamia crassipes* and *Geophilus electricus*. Four years after the summer flood, densities and number of species were similar to those known in communities of older floodplain forests not effected by this flood.

INTRODUCTION

The investigation of wetland ecosystems is an important task for ecologists. Floods play a significant role in shaping the soil fauna assemblages in alluvial areas. In geologically old ecosystems with long-term cycling of terrestrial and aquatic phases, such as in Central Amazonia, there are endemic species of terrestrial invertebrates. In contrast, in younger ecosystems, such as in Central Europe, the terrestrial invertebrate fauna is mainly composed of eurytopic species (Adis & Junk 2002). Terrestrial invertebrates occupying wetland habitats have developed different life strategies to survive short periods of high water levels and the associated low oxygen availability. Vertical and horizontal migration, recolonisation of flooded localities, and dormancy under water are examples of such strategies.

The impact of regular flooding on the soil macrofauna was studied by Tajovský (1999). He described the structure of communities from localities under different flood regimes. In Central Europe two types of floods can be differentiated: regular spring floods, which are rather short, and irregular floods, which can last longer and which have a more negative effect. This highly negative effect on the structure and size of a community of terrestrial isopods and on the population of one species, *Philoscia muscorum* (Scopoli, 1763), was shown in Germany by Haferkorn (1996). Similarly, half of the population of the terrestrial isopod *Periscyphis granai* Arcangeli, 1929 drowned during the irregular flood caused by a storm rainfall (Warburg *et al.* 1993).

The Litovelské Pomoraví Protected Landscape Area in Central Moravia, Czech Republic, is included in the list of registered wetlands under the Ramsar Convention. In July 1997, a disastrous flood occurred in the Litovelské Pomoraví PLA. Forests remained flooded for several weeks. The direct negative impact of this summer flood on soil macrofauna immediately after the flood was documented by Pižl and Tajovský (1998). The development of centipede communities in the following four years is described in this paper.

MATERIALS AND METHODS

The study area is situated about 10 km north-west of Olomouc town (49°65'N, 17°20'E, altitude 210 m). Communities of centipedes were studied in three forest localities: a 3 year old *Quercus* tree nursery (age in 1998) with *Urtica dioica* L. and *Rumex obtusifolius* L. in the herb layer and with a well-developed moss layer (*Brachythecium rutabulum* (Hedw.) Br. Eur.)) on clay-loam soil; a 30 year old semi-production forest with *Fraxinus excelsior* L. as the dominant tree species, and an 80 year old hardwood floodplain forest (*Querco-Ulmetum*). Both older forests had loamy-sandy to loamy soil with *Anemone nemorosa* L., *Polygonatum* spp., *Lathyrus vernus* (L.) Bernh. and *Maianthenum bifolium* L. F.W. Schmidt in the herb layer and *Eurhynchium hians* (Hedw.) Card in the moss layer. In November 1998, litter biomass (dry weight) was 184 g/m^2 in the 3 year old forest, 487 g/m^2 in the 30 year old forest, and 622 g/m^2 in the 80 year old forest. All three sites were only about 50 m apart and therefore their climatic and soil conditions were similar (annual precipitation 520 mm, mean annual temperature 9.1 °C, soil pH 4.8–5).

The study area is effected by irregular spring flooding for a few days about once in five years, but in the summer of 1997 it was effected by a disastrous flood. In the eastern part of the Czech Republic, Moravia, there were abnormally heavy rains. Six days of heavy rains (precipitation more than 50 mm per day) led to extensive floods in July. The second flood wave was caused by heavy rains ten days later. During this month, northern Moravia received three and a half times the mean July rainfall. The overflowing water washed away most of the litter from extensive forest areas. The flood water was approximately one metre deep and the study site remained inundated for six weeks. This type of flood event is expected to occur at a frequency of less than once per 1000 years.

Centipedes were sampled from March 1998 to February 2002. A row of six pitfall traps at 8 m intervals was set up at each locality to catch the epigeic part of the community. Traps (plastic containers with a diameter of 7 cm and height of 10 cm, filled with 4 % water solution of formaldehyde with detergent, and with metal covers against rain and leaves) were inspected and changed fortnightly (in winter at 28 day intervals). The endogeic part of the community was heat-extracted from soil samples using a modified Tullgren apparatus (60 W bulb about 10 cm above a soil sample left for 10–14 days). Five soil samples (circular metal corer with sample area 1/16 m^2, depth 10 cm) were taken monthly at each study site, about 10 m from the trap row.

In comparing years, the number of animals caught or extracted between May and November was used, and references to a year refer only to this period. To compare years, the mean catch (MC) was calculated as the number of individuals caught per six traps per four weeks ($MC=(N_c/w)\text{x}4$, where N_c is the number of animals caught in traps from May to November, and w is the number of weeks of this trapping period). The mean density of endogeic centipedes is expressed as the number of individuals per square meter ($MD=(N_d/35)\text{x}16$, where N_d is the number of animals extracted from soil samples from May to November).

TABLE 1.

Changes in the community structure of the epigeic (pifall traps) and endogeic part (soil samples) of the centipede community in 3 year old forest during post-flood succession. Mean catch (*MC*) ± standard error (individuals/6 traps/4 weeks), mean density (*MD*) ± standard error (individuals per square meter), D%: total dominance structure (number of individuals of a particular species as a percentage of the total number of centipedes caught or extracted from March 1998 to February 2002).

	epigeic part of community (pitfall traps)					**endogeic part of community (soil samples)**				
year	**1998**	**1999**	**2000**	**2001**		**1998**	**1999**	**2000**	**2001**	
mean ± standard error	MC ± SE	MC ± SE	MC ± SE	MC ± SE	D%	MD ± SE	MD ± SE	MD ± SE	MD ± SE	D%
Lithobius forficatus	0.3 ± 0.4		2.6 ± 2.1	1.9 ± 1.7	2.0	0.5 ± 1.2		1.4 ± 1.7	4.1 ± 5.8	1.0
Lithobius mutabilis	18.6 ± 8.6	87.9 ± 24.5	76.3 ± 22.0	52.4 ± 21.9	97.4	50.3 ± 21.1	39.3 ± 29.0	69.9 ± 19.7	96.9 ± 69.3	48.5
Lithobius agilis		0.4 ± 0.4		0.1 ± 0.4	0.3		1.4 ± 2.5		1.8 ± 2.5	0.5
Lithobius curtipes			0.1 ± 0.3		0.1		0.9 ± 1.6	0.9 ± 1.6	0.5 ± 1.2	0.5
Lithobius austriacus									0.5 ± 1.2	0.1
Strigamia acuminata			0.1 ± 0.3	0.3 ± 0.5	0.2	0.5 ± 1.2	0.5 ± 1.2	12.8 ± 10.9	27.9 ± 14.2	8.4
Strigamia transsilvanica						0.9 ± 1.6	0.9 ± 2.4	2.7 ± 3.9		0.7
Geophilus flavus						19.2 ± 4.9	43.4 ± 28.4	56.7 ± 29.7	48.9 ± 27.9	32.5
Geophilus electricus										0.1
Schendyla nemorensis						4.6 ± 6.6	7.8 ± 7.4	14.6 ± 19.5	12.8 ± 15.1	7.7
total ± standard error	18.8 ± 8.6	88.3 ± 24.4	79.1 ± 22.3	54.7 ± 22.6		75.9 ± 24.2	94.2 ± 53.8	159.1 ± 43.6	193.4 ± 100.3	

For statistical test of changes in density and catch, a generalised linear mixed model with logs of number of caught centipedes (or centipedes extracted from soil samples) as the response variable and localities and time as predictors was fitted (SAS Institute Ltd 1999). This model assumes Poisson error distribution takes catches within one locality as repeated measurements. I chose autoregressive covariance structure as indicated by the lowest value of Akaike's information criterion. The significance of effect was assessed by an F-test, with nominator and denominator degrees of freedom estimated by the Kenward-Roger method.

RESULTS

In total, 11 095 centipedes belonging to 14 species (two orders, four families) were collected and identified.

The number of centipedes trapped by pitfall traps increased significantly ($F_{1, 21\,2}$=5.27, p=0.032) during the study period in all localities, but there were no differences between localities ($F_{2, 18\,4}$=0.59, p=0.5635). The situation was similar for the endogeic component of the communities. There was a significant increasing trend in the number of extracted centipedes ($F_{1, 21\,1}$=5.57, p=0.028) during the entire study period at all localities, but there were no differences between the localities ($F_{2, 18\,2}$= 1.25, p=0.3104).

3 year old tree nursery

Ten species occurred in this locality. In the first year, there was a very low epigeic activity (*MC*) of centipedes, but this increased in the next year (Table 1). Although *MC* decreased during 1999–2001, the number of trapped centipede species increased. In contrast, the mean density (*MD*) of centipedes increased during the study period. The most dominant species in pitfall traps was *Lithobius mutabilis* L. Koch, 1862. The number of species trapped each year was relatively low, with the highest number recorded in the third and fourth year. Approximately the same

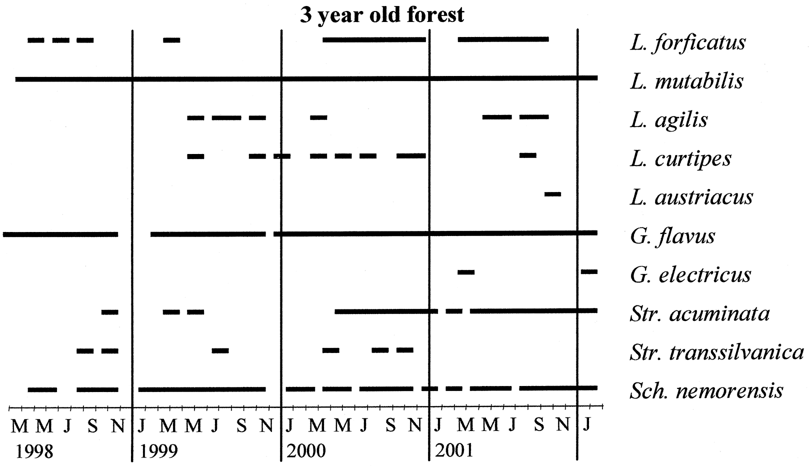

Fig. 1. Time-presence of centipede species during post-flood succession in the 3 year old forest.

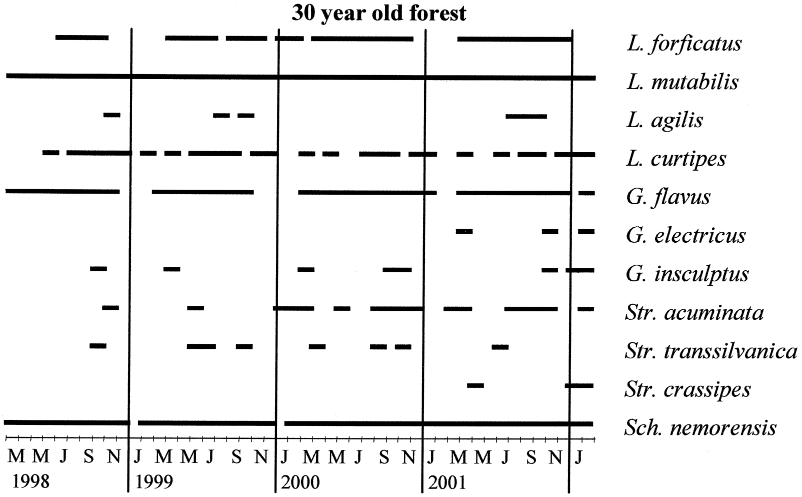

Fig. 2. Time-presence of centipede species during post-flood succession in the 30 year old forest.

number of extracted species was recorded each year. The most abundant endogeic species were *L. mutabilis* and *Geophilus flavus* (De Geer, 1778) at the beginning, and in the third year *Strigamia acuminata* (Leach, 1814) and *Schendyla nemorensis* (C. L. Koch, 1836) were also abundant (Table 1). *Lithobius austriacus* Verhoeff, 1937 was recorded at this locality only (Fig. 1).

30 year old semi-production forest with *Fraxinus excelsior*

In this forest, 11 species of centipedes were recorded. The *MC* showed the same pattern of changes as in the 3 year old forest (Table 2). The most dominant species were *L. mutabilis* and *Lithobius forficatus* (Linnaeus, 1758) in the epigeic part of community. The density of endogeic centipedes (*MD*) increased over the study period. The highest density and number of extracted species (11) at any of the three sites were recorded here in the fourth year of the study (Table 2, Fig. 2). The most dominant endogeic species were *S. nemorensis*, *L. mutabilis* and *G. flavus*.

80 year old hardwood floodplain forest

The highest number of species, 13, occurred in the oldest forest. Epigeic activity (*MC*) increased during 1998–1999 and stayed almost constant to the fourth year (Table 3). The most dominant species were *L. mutabilis* and *L. forficatus*, as in the 30 year old forest. The centipede *Lithobius erythrocephalus* C. L. Koch, 1847 was trapped at this locality only (Fig. 3). As at other localities, *MD* increased during the study period. The most abundant endogeic species were *S. nemorensis*, *L. mutabilis* and *G. flavus* (Table 3).

Occurrence of species during post-flood succession

Figures 1–3 show changes in the presence of centipede species at individual localities. Dominant, frequent, and some uncommon species showed up at the localities throughout the study period: *L. mutabilis*, *L. forficatus*, *Lithobius agilis* C. L. Koch, 1847, *Lithobius curtipes* C. L. Koch, 1847, *Lithobius aeruginosus* L. Koch, 1862, *L. erythrocephalus*,

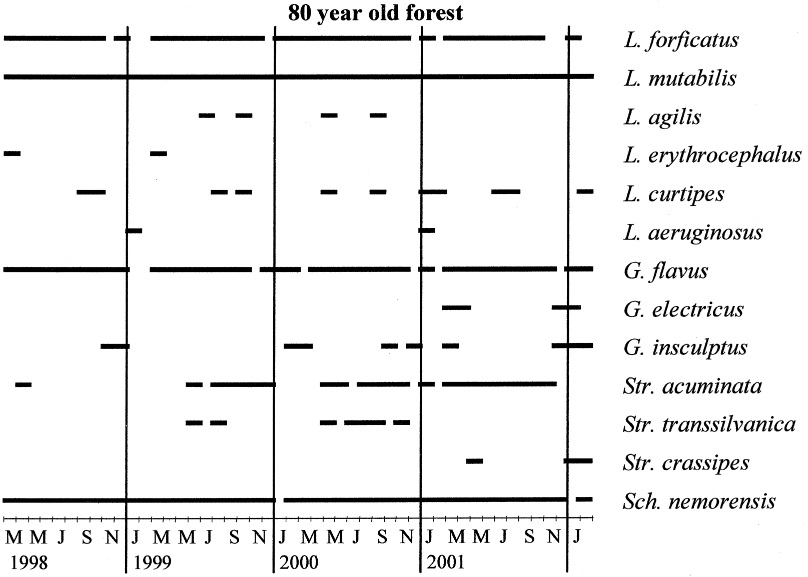

Fig. 3. Time-presence of centipede species during post-flood succession in the 80 year old forest.

S. acuminata, *Strigamia transsilvanica* (Verhoeff, 1928), *G. flavus*, *Geophilus insculptus* Attems, 1895 and *S. nemorensis*. Other species were recorded only as late as the fourth year of study: *L. austriacus, Strigamia crassipes* (C. L. Koch, 1835) and *Geophilus electricus* (Linnaeus, 1758). The year of sampling had a statistically significant effect on catches of all dominant species, but the effect of locality was not significant for species dominant in all forests (Table 4).

DISCUSSION

In Central Europe, centipedes on floodplains have been frequently studied. The composition of centipede assemblages has been studied in the floodplain forests in the Litovelské Pomoraví PLA, a part of the Morava River basin. Although 20 species of centipedes inhabit alluvial areas in this PLA (Tajovský 2000; Tuf 2000) nine to ten species were collected in individual floodplain softwood and hardwood forests (Pižl & Tajovský 1998; Tuf & Ožanová 1998). Communities of centipedes inhabiting *Fraxino-Ulmetum* forests near the confluence of the Dyje and Morava rivers were effected by the duration of inundation: in non-flooded forest there were nine to ten species, whereas in forests flooded briefly and regularly and in long-term flooded forest, there were only six species (Tajovský 1999). The same pattern was described at these sites for the density of endogeic centipedes. Similarly, in non-forested sites in the Morava valley in Austria, the duration of flooding is negatively correlated with the number of species (Zulka 1991). Annual changes in a species-poor community of centipedes affected by oscillation in the water regime were studied in the *Cariceto-Alnetum* forest (four centipede species) and *Querco-Ulmetum* forest (five species) of the Danube river-basin (Gulička 1960).

All centipede species captured in this study are known from alluvial areas in the Litovelské Pomoraví and from other hardwood floodplain forests. In floodplain forest

TABLE 2.

Changes in the community structure of the epigeic and endogeic part of the centipede community in 30 year old forest during post-flood succession. Mean catch (*MC*) ± standard error (individuals/6 traps/4 weeks), mean density (*MD*) ± standard error (individuals per square metre), D%: total dominance structure (number of individuals of a particular species as a percentage of the total number of centipedes caught or extracted from March 1998 to February 2002).

	epigeic part of community (pitfall traps)					**endogeic part of community (soil samples)**				
year	**1998**	**1999**	**2000**	**2001**		**1998**	**1999**	**2000**	**2001**	
mean ± standard error	MC ± SE	MC ± SE	MC ± SE	MC ± SE	D%	MD ± SE	MD ± SE	MD ± SE	MD ± SE	D%
Lithobius forficatus	2.0 ± 1.1	3.1 ± 1.4	6.9 ± 2.3	5.1 ± 4.2	8.9	0.5 ± 1.2	0.5 ± 1.2	0.9 ± 1.6	3.2 ± 4.1	0.6
Lithobius mutabilis	21.3 ± 12.0	60.9 ± 17.8	46.3 ± 12.2	42.3 ± 28.1	89.4	31.1 ± 21.7	17.8 ± 13.4	40.7 ± 18.0	111.1 ± 74.5	30.4
Lithobius agilis	0.1 ± 0.3	0.3 ± 0.4		0.3 ± 0.5	0.4		0.5 ± 1.2		0.5 ± 1.2	0.1
Lithobius curtipes	0.1 ± 0.3	0.1 ± 0.3	0.1 ± 0.3		0.3	3.2 ± 4.5	2.7 ± 3.4	2.3 ± 2.4	2.3 ± 3.0	1.8
Strigamia acuminata			0.3 ± 0.4	0.1 ± 0.4	0.3	0.5 ± 1.2	0.5 ± 1.2	1.4 ± 1.7	6.9 ± 9.9	1.5
Strigamia transsilvanica		0.1 ± 0.3	0.1 ± 0.3		0.1	0.5 ± 1.2	1.4 ± 1.7	0.5 ± 1.2	0.5 ± 1.2	0.3
Strigamia crassipes					0.3				2.3 ± 6.0	0.2
Geophilus flavus						18.7 ± 12.9	27.0 ± 18.6	41.6 ± 16.6	71.3 ± 36.6	21.2
Geophilus electricus									0.5 ± 1.2	0.1
Geophilus insculptus						0.5 ± 1.2	0.0 ± 0.0	0.9 ± 1.6	0.5 ± 1.2	0.5
Schendyla nemorensis	0.1 ± 0.3	0.3 ± 0.4		0.1 ± 0.4	0.3	45.3 ± 26.6	44.3 ± 47.7	78.6 ± 80.0	123.0 ± 85.5	43.2
total ± standard error	23.7 ± 12.2	64.9 ± 18.4	53.6 ± 13.6	48.0 ± 27.6		100.1 ± 47.0	94.6 ± 63.2	166.9 ± 89.9	321.8 ± 171.6	

without regular flooding, *L. mutabilis* and *L. forficatus* are dominant in the epigeic part of the community. In forest with regular brief flooding, only *L. mutabilis* is dominant, whereas in long-term flooded forest *L. mutabilis* is absent and *L. curtipes* dominates (Tajovský 1999). In non-forested flooded areas *Lamyctes emarginatus* (Newport, 1844) is a dominant species (Zerm 1997), as is *L. curtipes* (Zulka 1991).

The development of centipede communities after irregular floods has not been carefully studied, except for the immediate impact of summer flooding as described by Pižl & Tajovský (1998). They noted that the summer flood had three negative influences on terrestrial invertebrates, including centipedes in the Litovelské Pomoraví PLA: (1) animals and litter were washed away, (2) long-term submersion in warm water (with low oxygen concentration), and (3) an overlap of the soil surface by a mud layer and the subsequent dessication of this layer. It was shown that the densities of endogeic centipedes were 10 times lower after the flood (May vs September 1997) and in addition, that species richness decreased.

In the first year of this study, low numbers of species, mean catches, and mean densities were expected. However, these densities (*MD*) were higher compared to those measured immediately after the flood (autumn 1997, Fig. 4, level *g* and *h*). After four years, species richness was higher than in the first year. During this period an additional three species, which are widespread but uncommon in woodlands, appeared: *L. austriacus,*

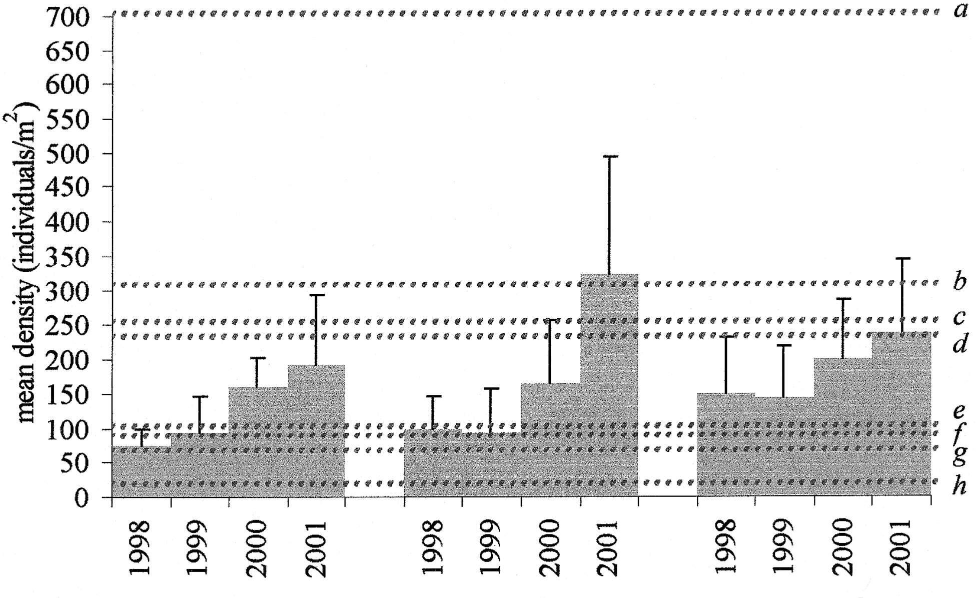

Fig. 4. Comparison of mean endogeic density of centipedes (mean for vegetation season) in studied forests with densities from other floodplain forests. *a*: Floodplain forest in Litovelské Pomoraví PLA (Pižl & Tajovský 1998). *b*: Floodplain forest in Danube River basin (Gulička 1960). *c*: Flood-proof floodplain forest near the confluence of Morava River and Dyje River (Tajovský 1999). *d*: Floodplain forest in Litovelské Pomoraví PLA (Pižl & Tajovský 1998). *e*: Floodplain forest with regular short spring floods (Tajovský 1999). *f*: Floodplain forest with long-term spring floods (Tajovský 1999). *g*: Floodplain forest shortly after summer flood (Pižl & Tajovský 1998). *h*: Floodplain forest shortly after summer flood (Pižl & Tajovský 1998).

TABLE 3.

Changes in the community structure of the epigeic and endogeic part of the centipede community in 80 year old forest during post-flood succession. Mean catch (*MC*) ± standard error (individuals/6 traps/4 weeks), mean density (*MD*) ± standard error (individuals per square metre), D%: total dominance structure (number of individuals of a particular species as a percentage of the total number of centipedes caught or extracted from March 1998 to February 2002).

	epigeic part of community (pitfall traps)					**endogeic part of community (soil samples)**				
Year	**1998**	**1999**	**2000**	**2001**		**1998**	**1999**	**2000**	**2001**	
Mean ± standard error	MC ± SE	MC ± SE	MC ± SE	MC ± SE	D%	MD ± SE	MD ± SE	MD ± SE	MD ± SE	D%
Lithobius forficatus	2.6 ± 0.9	8.7 ± 2.6	6.6 ± 2.4	4.7 ± 4.3	8.3	0.9 ± 1.6	1.4 ± 3.6	0.9 ± 1.6	1.4 ± 2.5	0.8
Lithobius mutabilis	35.9 ± 22.5	76.4 ± 22.5	68.7 ± 13.4	82.1 ± 49.6	90.7	34.7 ± 26.3	26.5 ± 16.3	37.5 ± 17.6	51.2 ± 28.2	24.4
Lithobius erythrocephalus					0.1					
Lithobius agilis			0.4 ± 0.6		0.2		0.9 ± 1.6	0.1		
Lithobius curtipes				0.3 ± 0.8	0.1	1.8 ± 3.6	0.9 ± 1.6	0.9 ± 1.6	0.5 ± 1.2	0.6
Lithobius aeruginosus										0.3
Strigamia acuminata					0.2		3.7 ± 3.4	4.6 ± 4.8	4.6 ± 2.5	1.6
Strigamia transsilvanica			0.1 ± 0.3	0.0			0.9 ± 1.6	8.2 ± 12.6		0.9
Strigamia crassipes					0.0					0.1
Geophilus flavus		0.1 ± 0.3	0.1 ± 0.3		0.1	23.8 ± 8.4	34.7 ± 28.9	47.1 ± 34.2	61.7 ± 25.2	21.3
Geophilus electricus										0.2
Geophilus insculptus						0.5 ± 1.2		0.5 ± 1.2		0.7
Schendyla nemorensis	0.1 ± 0.3		0.1 ± 0.3		0.2	87.3 ± 65.5	75.9 ± 63.1	101.0 ± 69.7	118.9 ± 66.6	48.8
total ± standard error	36.8 ± 22.3	85.3 ± 23.4	76.1 ± 14.0	87.1 ± 52.6		149.0 ± 84.5	144.9 ± 74.4	200.7 ± 84.0	238.2 ± 106.5	

S. crassipes and *G. electricus* (Kaczmarek 1979; Barber & Keay 1988). In contrast, *L. erythrocephalus*, which was captured in the first year only, is a very common eurytopic species (Kaczmarek 1979; Tajovský 2001). Nevertheless, non-presence in traps or soil samples can be caused not only by non-presence in the study area, but by low population size as well.

Endogeic population densities increased at all three sites. This was mainly caused by increased density of dominant species (Table 4). This trend can be explained by simultaneous restoration of populations of other faunal groups which can become prey for centipedes (Tufová 2002; Tuf in press). It is known that an increase in prey (collembolans, larvae of Diptera) increases the density of centipedes (Chen & Wise 1999) and that an increase in density of centipedes is associated with a decrease in density of collembolans and mites (Poser 1988). Centipedes can prey on woodlice, as was shown for the isopod *P. muscorum* (length 1 cm) and the centipede *L. forficulatus* (2–3 cm) in a grassland ecosystem (Sunderland & Sutton 1980). Smaller woodlice, such as *Trichoniscus pusillus* Brandt, 1833 (3–4 mm) or *Hyloniscus riparius* C. L. Koch, 1838 (5–6 mm), represent possible food resources for the most dominant centipede *L. mutabilis* (15 mm). There was a significant correlation between changes in the *MD* of *T. pusillus* and the centipede *L. mutabilis* (Tuf in press).

Differences between changes in *MC* and *MD* are related to age-development of centipedes. The life span of *L. mutabilis* is five years (Albert 1983). The endogeic density of the centipede *L. mutabilis* decreased in the second year of study, but there was also a rapid increase in their epigeic activity. This was caused by changes of biology during age-development in the recovering population. It has been found that this flood eliminated almost all postembryonic developmental stages but had not destroyed eggs (Tuf 2002). A new generation of *L. mutabilis* appeared in spring 1998. During this year centipedes developed from the eggs to the third postlarval stage, with high recordable density and low epigeic activity. From the third postlarval stage, this species shows high epigeic activity and lower recordable densities. Therefore, mainly these older stages with high *MC* and lower *MD* were in the area in 1999. During these two years this generation matured and laid eggs, which led to a strong 2000 generation.

TABLE 4.

Statistical significance for effects of year and locality on catches of dominant species of centipedes during four years after a summer flood. (Epigeic part of population = catches in pitfall traps, endogeic part of population = number of centipedes extracted from soil samples).

part of population	**species**	**effect**	**df**	**F**	**p**
Epigeic part	*L. mutabilis*	year	1, 21.7	6.09	0.0219
		locality		*ns*	
	L. forficatus	year	1, 31.9	12.52	0.0013
		locality	2, 28.1	6.45	0.005
Endogeic part	*L. mutabilis*	year	1, 29	11.81	0.0018
		locality		*ns*	
	G. flavus	year	1, 23.4	7.09	0.0138
		locality		*ns*	
	Str. acuminata	year	1, 34	35.43	<.0001
		locality	2, 31.7	9.91	0.0005
	Sch. nemorensis	year	1, 31.3	5.85	0.0216
		locality	2, 26.9	10.00	0.0006

Endogeic centipede densities increased over the study period and reached values found in similar forests in the fourth year (Fig. 4, level *d* and *c*). In the Litovelské Pomoraví before summer flooding, there were 237 individuals/m^2 and 701 individuals/m^2 respectively (Pižl & Tajovský 1998). In the softwood floodplain forest in the Danube River basin, there was also a high density of centipedes, 304 individuals/m^2 (Gulička 1960). Tajovský (1999) compared forests with different flooding regimes, and recorded 94 individuals/m^2 in forest with long-term spring floods, 102 individuals/m^2 in forest with short spring floods and 252 individuals/m^2 in forest without floods. In the present study, the highest *MD* was 321.8 individuals/m^2 in the 30 year old forest in the last year, similar to the density recorded in softwood forest near the Danube River (Fig. 4, level *b*). Nevertheless, the reported value for density of centipedes in floodplain forest with short or long-term floods was achieved in the first or second year (Fig. 4, level *e* and *f*).

The size and structure of centipede communities was unstable throughout the observation period, but there were significant increasing trends. Although there were no significant differences between sites, the higher number of species and endogeic density were in older forests. This indicates the high importance of older forest stands for restoration of soil fauna communities.

Although the number of species and endogeic densities were similar to those of communities not effected by the summer flood, the restoration of centipede communities in terms of all parameters represents a long-term process. Therefore it is important to pursue long-term investigations of these successional processes.

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